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The principal accomplishment of this study is the development of quite different theory for nonlinear instabilities in shear flows. This theory is an asymptotic one and not 'ad hoc'. Despite many attempts in the past the existing theories appear to be too weak mathematically and fail to capture the essentials of the nonlinear dynamical process in the breakdown of laminar flow. In particular the crucial elements of strong mean flow distortion and three dimensionality have not played an important role in past studies. The new theory, called the mean flow-first harmonic theory, remedies these two defects and shows why they are expected to be critical factors in a nonlinear theory. It is shown that there exists a truly nonlinear interaction between the evolving mean flow and one or more first harmonic waves. Both viscous and inviscid flow problems have been considered. In particular detailed calculations have been made for free surface flows, channel flow, and the Blasius boundary layer. Wake and mixing layer problems are currently under study.

The second development concerns the critical layer singularity that arises in inviscid shear flows. In the past this difficulty for perfect fluids has been circumvented by using viscosity or nonlinearity. Each of these two limits lead to different results concerning the phase change and therefore the eigenvalues. A third and possibly more relevant limit is to consider a wave packet analysis in the neighborhood of the critical level. Such an analysis suggests that most amplified and damped disturbances are permitted in this limit. Further work is in progress.

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Nonlinear Wave Phenomena In Hydrodynamics

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